32. Workshop der quantitativen Betriebswirtschaftslehre (QBWL)

20.03.2023 – 23.03.2023

Bad Windsheim

QBWL-Workshop 2023 Agenda

Montag, 20.03.2023	Dienstag, 21.03.2023
	7:00 - 8:15 **Frühstück**
	8:30 - 9:45 **Sitzung 4: Scheduling und Losgrößenplanung**
	9:45 - 10:15 **Kaffeepause**
	10:15 - 11:30 **Sitzung 5: Tourenplanungsprobleme**
	11:40 - 12:20 **Sitzung 6: Machine-Learning-Ansätze**
	12:20 - 13:20 **Mittagessen**
	13:30 - 14:30 **Tutorium: Online-Optimierung**
14:30 - 15:00 **Kaffee und Kuchen**	**14:40 - 15:45** **Sitzung 7: Planungsprobleme in der Gesundheitsversorgung**
15:00 - 15:45 **Begrüßung und Vorstellung der Lehrstühle**	**15:45 - 16:15** **Kaffeepause**
15:45 - 16:50 **Sitzung 1: Planungsprobleme in der Lagerhaltung**	**16:15 - 17:30** **Sitzung 8: Diverse OR Anwendungen II**
17:00 - 17:50 **Sitzung 2: Operations Management im Handel I**	**17:40 - 18:45** **Sitzung 9: Scheduling**
18:00 - 18:45 **Sitzung 3: Diverse OR Anwendungen I**	
18:45 - 19:45 **Abendessen**	**18:45 - 19:45** **Abendessen**
20:00 **Treffen der Professoren**	**20:00 - 21:00** **Rückblick auf die QBWL-Geschichte**

Mittwoch, 22.03.2023	Donnerstag, 23.03.2023
7:00 - 8:15 **Frühstück**	**7:00 - 8:15** **Frühstück**
8:30 - 9:45 **Sitzung 10: Kapazitäts- und Produktionsplanung**	**8:30 - 9:35** **Sitzung 14: Operations Management im Handel II**
9:45 - 10:15 **Kaffeepause**	**9:35 - 10:00** **Kaffeepause**
10:15 - 11:35 **Sitzung 11: Stochastische Produktionsplanung**	**10:00 - 11:05** **Sitzung 15: Planungsprobleme in Logistik und Katastrophenschutz**
11:45 - 12:35 **Sitzung 12: Optimierungsprobleme in Logistik und Transport I**	**11:15 - 11:55** **Sitzung 16: Optimierungsprobleme in Logistik und Transport II**
	11:55 - 12:20 **Verabschiedung**
12:35 - 13:35 **Mittagessen**	**12:30 - 13:30** **Mittagessen**
13:35 - 14:15 **Sitzung 13: Flughafenlogistik**	
14:45 - 16:30 **Längere Wanderung und anschließend** **16:30 - 18:00** **Führungen im Freilandmuseum**	
oder	
15:15 - 16:00 **Kürzere Wanderung und anschließend** **16:00 - 18:00** **Führungen im Freilandmuseum**	
18:00- 20:00 **Beginn Bierverkostung und Abendessen im Wirtshaus "Wirtschaft am Kommunbrauhaus"**	

Tagungsprogramm QBWL-Workshop 2023

Montag, 20.03.2023

14:30 - 15:00 Kaffee und Kuchen
15:00 - 15:45 Begrüßung und Vorstellung der Lehrstühle
Prof. Dr. Alena Otto (Universität Passau)
Prof. Dr. Justus Arne Schwarz (Universität Regensburg)

1. Sitzung, Leitung: Prof. Dr. Martin Grunow (Technische Universität München)

15:45 - 16:50 Planungsprobleme in der Lagerhaltung

Sebastian Debold (Universität Duisburg-Essen) 25 min
A rackplanning approach for non-additive products

Moritz Hundhammer (Katholische Universität Eichstätt-Ingolstadt) 25 min
Combining robotic and manual picking for store-specific palletizing in a parts-to-picker distribution center

Amir Hosseini (Universität Passau) 15 min
Automated guided vehicle scheduling problem with battery constraints

2. Sitzung, Leitung: Prof. Dr. Raik Stolletz (Universität Mannheim)

17:00 - 17:50 Operations Management im Handel I

Sandra Zajac (Katholische Universität Eichstätt-Ingolstadt) 25 min
A multi-phase optimization algorithm for shelf space planning in the non-food area of grocery stores

Lena Riesenegger (Technische Universität München) 25 min
Managing surplus food in grocery retail

3. Sitzung, Leitung: Prof. Dr. Jens Brunner (Universität Augsburg)

18:00 - 18:45 Diverse OR Anwendungen I

Annegret Lewak (RWTH Aachen) 15 min
Investment alternatives selection to maximize low income investors returns

Michelle Mitter (Universität Duisburg-Essen) 15 min
Incompletely specified products in strategic operations management

Frank Wiedra (Helmut-Schmidt-Universität/
Universität der Bundeswehr Hamburg) 15 min
Personnel scheduling in RoRo-terminals

18:45 - 19:45 Abendessen
20:00 Treffen der Professoren

Dienstag, 21.03.2023

7:00 - 8:15 Frühstück

4. Sitzung, Leitung: Prof. Dr. Florian Sahling (Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau)

8:30 - 9:45 Scheduling und Losgrößenplanung

Lars Jäger (Leibniz Universität Hannover) 25 min
Exact solution of capacitated dynamic lot sizing problems by branch-and-price algorithms using the SCIP framework

Sebastian Wegel (Leibniz Universität Hannover) 25 min
Scheduling of parallel continuous annealing lines with alternative processing modes to optimize efficiency under tardiness constraints

Sarah Roth (Universität Mannheim) 25 min
Workforce scheduling with split shifts

9:45 - 10:15 Kaffeepause

5. Sitzung, Leitung: Prof. Dr. Manuel Ostermeier (Universität Augsburg)

10:15 - 11:30 Tourenplanungsprobleme

Stefan Voigt (Katholische Universität Eichstätt-Ingolstadt) 25 min
Meta-analysis of operators in ALNS for vehicle routing problems

Niklas Tuma (Technische Universität München) 25 min
Logic-based Benders decomposition for a vehicle routing problem with a zone-based tariff scheme

David Fleckenstein (Universität Augsburg) 25 min
Integrated demand management and vehicle routing for shared mobility-on-demand systems in rural areas

6. Sitzung, Leitung: Prof. Dr. Sven Müller (RWTH Aachen)

11:40 - 12:20 Machine-Learning-Ansätze

Milena Grieger (Universität Augsburg) 15 min
A sensitivity flexible Machine Learning classifier for predicting ICU capacity usage

Seyed Mohammad Zenouzzadeh (Universität Mannheim) 25 min
A Machine Learning approach for the analysis of time-dependent queues: ML4TDQ

12:20 - 13:20 Mittagessen

Tutorium, Leitung: Prof. Dr. Erwin Pesch (Universität Siegen)

13:30 - 14:30 Online-Optimierung 60 min

Prof. Dr. Alena Otto (Universität Passau)

7. Sitzung, Leitung: Prof. Dr. Sebastian Schiffels (Universität Augsburg)

14:40 - 15:45 Planungsprobleme in der Gesundheitsversorgung

Lorena S. Reyes-Rubiano (RWTH Aachen) 25 min
Evaluation of an integrated mobility concept for home care workers and ambulant patients

Markus Schüller (Universität Augsburg) 25 min
An approach for automated vacation planning in hospitals under consideration of employee satisfaction

Mira Baude (Universität Duisburg-Essen) [abgesagt] 15 min
Minimizing humanitarian and economic damage in pandemic situations

15:45 - 16:15 Kaffeepause

8. Sitzung, Leitung: Prof. Dr. Simone Neumann (Universität Hamburg)

16:15 - 17:30 Diverse OR Anwendungen II

Thomas Hagspihl (Technische Universität München) 25 min
Improving airport access: On finding the optimal positions of vertiports for air taxis

Tobias Huf (Universität Augsburg) 25 min
Robots at your service: Covering the last-mile in omnichannel retail

Dr. Matthias Soppert (Universität der Bundeswehr München) 25 min
Optimal Counterfactual Explanations for Target Score Value Distributions of Random Forest Predictors

9. Sitzung, Leitung: Prof. Dr. Dominik Kreß (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg)

17:40 - 18:45 Scheduling

Andreas Hipp (Helmut-Schmidt-Universität/
Universität der Bundeswehr Hamburg) 15 min
Scheduling problems considering jobs with fixed position

Maximilian Kolter (Technische Universität München) 25 min
A branch-and-price approach for solving the multi-criteria multi-project scheduling problem for engineering automotive production systems

Julian Lütkemeyer (Universität Duisburg-Essen) 25 min
Simultane Personaleinsatz- und Maschinenbelegungsplanung

18:45 - 19:45 Abendessen

Rückblick, Leitung: Prof. Dr. Knut Haase (Universität Hamburg)

20:00- 21:00 Rückblick auf die QBWL-Geschichte 60 min

Prof. Dr. Dr. h.c. Bernhard Fleischmann (Universität Augsburg)
Prof. Dr. Horst Tempelmeier (Universität zu Köln)

Mittwoch, 22.03.2023

7:00 - 8:15 Frühstück

10. Sitzung, Leitung: Prof. Dr. Michael Manitz (Universität Duisburg-Essen)

8:30 - 9:45 Kapazitäts- und Produktionsplanung

Niklas Owens (Universität Regensburg) 25 min
A model and initial results for optimal product rollover strategies under uncertain supply

Mirko Schömig (Technische Universität München) 25 min
Production capacity planning under demand and productivity learning rate uncertainty

Sebastian Schoepf (Universität Hohenheim) 25 min
Resilientes Master Planning in der Elektronik

9:45 - 10:15 Kaffeepause

11. Sitzung, Leitung: Prof. Dr. Stefan Helber (Leibniz Universität Hannover)

10:15 - 11:35 Stochastische Produktionsplanung

Antonia Thiemeyer (Bergische Universität Wuppertal) 25 min
Scheduling maintenance activities subject to stochastic job-dependent machine deterioration

Jan-Niklas Dörr (Technische Universität München) 15 min
Action space designs for stochastic production scheduling with sequence-dependent setup times

Thorsten Greil (Technische Universität München) 15 min
The environmental impact of considering uncertainty in supply chain planning

Baturhan Bayraktar (Technische Universität München) 25 min
Stochastic programming for solving the dynamic assembly matrix layout problem

12. Sitzung, Leitung: Prof. Dr. Florian Jaehn (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg)

11:45 - 12:35 Optimierungsprobleme in Logistik und Transport I

Rea Röntgen (Bergische Universität Wuppertal) 25 min
Free-floating electric carsharing problem with partial charging

Kai Winheller (Universität Duisburg-Essen) 25 min
Dynamic compensations for occasional drivers

12:35 - 13:35 Mittagessen

13. Sitzung, Leitung: Prof. Dr. Heinrich Kuhn (Katholische Universität Eichstätt-Ingolstadt)

13:35 - 14:15 Flughafenlogistik

Finn Meissner (Helmut-Schmidt-Universität/ Universität der Bundeswehr Hamburg) 15 min
Determining airplane boarding groups

Niklas Pöch (Leibniz Universität Hannover) 25 min
Vehicle routing for inductive charged passenger buses on airport aprons

14:45 - 16:30 Längere Wanderung und anschließend
16:30 - 18:00 Führungen im Freilandmuseum
oder
15:15 - 16:00 Kürzere Wanderung und anschließend
16:00 - 18:00 Führungen im Freilandmuseum

18:00 - 20:00 Bierverkostung und Abendessen im Wirtshaus "Wirtschaft am Kommunbrauhaus"

Donnerstag, 23.03.2023

7:00 - 8:15 Frühstück

14. Sitzung, Leitung: Prof. Dr. Alexander Hübner (Technische Universität München)

8:30 - 9:35 Operations Management im Handel II

Marius Drechsler (Hochschule Geisenheim University) 25 min
Procurement and production planning for horticulture with consideration of short-term re-orders

Alexander Pahr (Technische Universität München) 15 min
Ameliorating food inventory management

Julia Heger (Universität Augsburg) 25 min
Partition-constrained assortment optimization under the multinomial logit model

9:35 - 10:00 Kaffeepause

15. Sitzung, Leitung: Prof. Dr. Claudius Steinhardt (Universität der Bundeswehr München)

10:00 - 11:05 Planungsprobleme in Logistik und Katastrophenschutz

Christin Münch (Universität Duisburg-Essen) [abgesagt] 25 min
Zum Path Planning Problem für Drohnen unter Berücksichtigung von Geschwindigkeit und Energieverbrauch

Karolin Eisele (Universität Duisburg-Essen) 15 min
Zellenbasierte Ansätze für das Firefighter Problem am Beispiel der Hochwasserbekämpfung

Christian Jäck (Universität Duisburg-Essen) 25 min
How to load your auto-carrier. A hybrid bin-packing approach for the auto-carrier loading problem (ACLP)

16. Sitzung, Leitung: Prof. Dr. Rouven Schur (Universität Duisburg-Essen)

11:15 - 11:55 Optimierungsprobleme in Logistik und Transport II

Karen Flores-Hundt (Universität Duisburg-Essen) [abgesagt] 15 min
Budgetallokation in der Katastrophenhilfe zur Bereitstellung von Transportkapazitäten

Abtin Nourmohammadzadeh (Universität Hamburg) 25 min
A matheuristic approach for the family travelling salesman problem

11:55 - 12:20 Verabschiedung
12:30 - 13:30 Mittagessen

Abstracts

1. Sitzung, Leitung: Prof. Dr. Martin Grunow (Technische Universität München)

Sebastian Debold (Universität Duisburg-Essen, Prof. Dr. Jochen Gönsch)

A rackplanning approach for non-additive products

In order picking, a small number of goods is extracted from a warehousing system to satisfy a number of independent customer orders. The picking process -which is highly labor intensive- deeply impacts the overall logistic costs and the service level provided to the customer. Due to cost efficiency the so-called "zone picking" is a more frequently used order picking system. In zone picking the picking area is divided into multiple zones, where each zone is assigned to one or more operator. All picking zones are connected by a conveyor, on which boxes are being placed, each box corresponding to one customer order. The conveyor transports the boxes to the picking zones where SKUs ("Stock-Keeping-Units") are placed into the boxes. The maximal throughput of a zone picking system is largely determined by the capability to equally distribute the workload over all zones. To balance the workload equally, it is necessary to decide which SKUs are available in which zone. This process is called "rackplanning". In this talk we present a rackplanning approach for small to medium sized assortments.

Moritz Hundhammer (Katholische Universität Eichstätt-Ingolstadt, Prof. Dr. Heinrich Kuhn)

Combining robotic and manual picking for store-specific palletizing in a parts-to-picker distribution center

We examine an internal retail chain with a highly automated distribution center (DC) and associated stores. In the DC, two different technologies are used sequentially for loading store pallets. One part of the case packs (CPs) is packed by robots and another part by conventional order pickers according to the parts-to-picker principle. The stores are regularly supplied with several pallets by the DC. The allocation and sequence of the CPs on the pallets has a significant influence on instore efficiency during shelf-filling operations. At the same time, due to the different technologies used in the DC, CPs cannot be assigned to pallets in an arbitrary manner. Likewise, the allocation of CPs to pallets also influences the operational costs in the DC. This paper takes an integrative perspective and considers the interdependencies and cost effects of both subsystems (i.e., DC and store) and represents them by means of a directed graph. The problem is formulated similarly to a route planning problem and solved for practical instances of a European retail company. Compared to the existing approach, the non-optimal solutions for the problem instances already promise a reduction of distances to be covered during shelf filling

in the stores by 22% and a reduction of the decision-relevant costs in the DC by 67%. Across the internal supply chain, savings of 21.5% on average can be realized.

Amir Hosseini (Universität Passau, Prof. Dr. Alena Otto)

Automated guided vehicle scheduling problem with battery constraints

In many modern warehouses and factories, AGVs are widely used to perform transportation tasks of moving jobs, or products, between different entities. AGVs are constrained by their battery capacity and are out of service during their recharging periods. The AGV scheduling problem is a special case of the pickup and delivery problem, whose aim is to assign the transportation tasks to the AGVs, as well as sequence the assigned tasks, and schedule the recharging periods of each AGV, such that the makespan is minimized. In this study, a new bin packing-based mixed-integer linear programming (MILP) formulation is developed for the problem which outperforms state-of-the-art models, namely, vehicle routing-based and parallel machines-based models, respectively.

2. Sitzung, Leitung: Prof. Dr. Raik Stolletz (Universität Mannheim)

Sandra Zajac (Katholische Universität Eichstätt-Ingolstadt, Prof. Dr. Heinrich Kuhn)

A multi-phase optimization algorithm for shelf space planning in the non-food area of grocery stores

In grocery retail, shelf space is a valuable asset in both food and non-food area. An essential task is thus to select and to place items on shelf units. In the food segment, the shelf units usually consist of several shelves in potentially varying vertical distance to each other on which the items are stacked. In the non-food area, the items are partly stacked on shelves, party placed in a hanging position on the perforated back wall of the shelf unit. Movable shelf units often exhibit different dimensions than non-movable ones. As a result, the items potentially have different measurements depending on the shelf and placement type in a two-dimensional model. In this talk, the following problem is investigated: Which items should be selected and placed onto which shelf unit in which placement type so that practical constraints are satisfied? The problem is decomposed and solved by means of a multi-phase optimization algorithm. We demonstrate the good applicability of the solution approach using real-life case studies.

Lena Riesenegger (Technische Universität München, Prof. Dr. Alexander Hübner)

Managing surplus food in grocery retail

Although efficient planning of inventory in grocery stores is an important area of any retailer, it is nearly impossible to decrease food waste in retail stores to zero purely by prevention. Due to high customer expectations for freshness and availability and the stochastic nature of demand, store managers are forced to provide full shelves throughout the day by maintaining excess inventory. As a result, some products, particularly perishables such as meat, fish, dairies, and fruits and vegetables, cannot be sold before they expire or spoil.
When products are close to their expiration date, retailers resort to two well-known options to ensure food does not have to be discarded: Discounts and donations. However, this is often an either-or decision, and the option chosen usually follows a standardized procedure that does not take into account customer demand in the next few days, demand dependencies such as price- and freshness sensitivity of customers, replenishment cycles, and sorting or labelling costs. Taking these aspects into account, the strategy for products close to expiration can be more diverse. For example, a part of the products is donated, while the other part is sold at a reduced price. In this way, not only profits can be increased, but also food waste can also be minimized.
Using a simulation model, we aim to develop insights into more efficient salvaging decisions about near-to-expire overstocks in grocery retail.

3. Sitzung, Leitung: Prof. Dr. Jens Brunner (Universität Augsburg)

Annegret Lewak (RWTH Aachen, Prof. Dr. Sven Müller)

Investment alternatives selection to maximize low income investors returns

We observe strong growth in the renewable energy markets, but profits are mainly allocated to investors (choice makers) with high income. Based on findings of behavioral finance theory we build a model, that enables broader participation of low disposable income investors in renewable energy projects.
Therefore, the entrepreneur (decision maker) selects a number of projects from a set of candidate projects to maximizes the financial returns for investors with particular high weights for low disposable incomes with respect to capacities and minimum profit constraints. Choice makers opt for projects that contribute to their idiosyncratic utility function in terms of financial portfolio and some altruistic values. We present first numerical results and an outlook on a future empirical study to generate the coefficients of the utility function of the choice makers.

Michelle Mitter (Universität Duisburg-Essen, Prof. Dr. Jochen Gönsch)

Incompletely specified products in strategic operations management

Incompletely specified products (ICSP) are offered with increasing popularity in many industries. These products consist of a predefined set of alternative component products, from which the seller chooses one product after the sale. Thus, the customer does not know the exact specification of an ICSP before purchasing it.
Priceline and Hotwire are internationally very well-known examples from the travel industry. They form a set of up to three hotels, offer this set cheaper than the individual hotels, and tell a buyer who chooses the set of hotels the exact hotel after the purchase. Examples from the drugstore industry are the beauty boxes Blissim and PinkBox. Too Good To Go and Lidl Rettertüte are examples of ICSPs in the food industry.
The latter examples strongly illustrate that ICSPs help to make better use of resources and thus reduce waste. ICSP suppliers benefit from two systematic advantages. On the one hand, the supplier benefits from additional flexibility if he does not specify the product immediately after purchase, since there is less uncertainty about demand at a later stage. On the other hand, ICSPs, due to their inherent uncertainty, allow market segmentation by strength of customer preference for the individual alternatives of the ICSP. As a result, customers' individual willingness to pay can be skimmed off better than by traditional products alone.
In strategic operations management, we study basic effects of ICSPs and provide explanations why and in which cases ICSPs exist. We use sterilized models, which we solve in closed form. We anticipate rational, strategic customers who maximize their utility. The solution of the models is analytically optimal for a certain given market structure. The solution shows in which cases which traditional products are combined to ICSPs, how all products are priced and which market segmentation results.

Frank Wiedra (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg, Prof. Dr. Florian Jaehn)

Personnel scheduling in RoRo-terminals

Roll-on/Roll-off-operations (RoRo-operations) describe all processes concerning maritime transshipment of vehicles in RoRo-terminals and maritime transportation with RoRo-ships. To face increasing operational costs and throughputs, especially the field of Operations Research can offer possibilities to support efficient and effective RoRo-operations. In this case study we focus on personnel scheduling in RoRo-terminals, which means to schedule personnel who drive vehicles so that they can roll on or off RoRo-ships. In addition, personnel lash vehicles for security on decks and drive shuttles for moving personnel between the RoRo-ship and the vehicles in parking areas, also called batches. Often it becomes necessary to use

external personnel, for example from temporary employment agencies, in addition to internal personnel. Apart from these mono- and multi-skilled personnel, especially weightings of batches help to make a decision, which batches will be processed and which will be not. We use Constraint Programming to set up an optimization model and develop a rule-based heuristic motivated by the idea of a manual planner. As a result, we identify some criteria that are characteristic for efficient and effective personnel schedules.

4. Sitzung, Leitung: Prof. Dr. Florian Sahling (Rheinland-Pfälzische Technische Universität Kaiserslautern-Landau)

Lars Jäger (Leibniz Universität Hannover, Prof. Dr. Stefan Helber)

Exact solution of capacitated dynamic lot sizing problems by branch-and-price algorithms using the SCIP framework

We consider the problem to solve the multi-level capacitated lot sizing problem (MLCLSP) via a branch-and-price algorithm based on a Dantzig-Wolfe decomposition by product types.
A convex combination of Wagner-Within solutions as in Manne's model from 1958 is known not to be sufficient to reproduce the entire solution space of the MLCLSP. In this paper, we therefore decouple the decisions on the setup patterns, to be made in the pricing problems, from those on the production quantities, to be made in the LP master problem. Due to the special cost structure, the solutions of the subproblems can be obtained in linear time. The resulting branch-and-price algorithm has been implemented using the SCIP framework.
We present the underlying problem decomposition, the implementation and some first numerical results.

Sebastian Wegel (Leibniz Universität Hannover, Prof. Dr. Stefan Helber)

Scheduling of parallel continuous annealing lines with alternative processing modes to optimize efficiency under tardiness constraints

Continuous annealing is a core process in steel cold-rolling facilities, where order-specific long steel strips, wound up to coils, are processed through an annealing furnace in a continuous strip to achieve defined material properties. To enable a continuous process, the coils are welded together before entering the line and are separated again afterward. Coil-specific characteristics, such as width, thickness, and annealing temperature impose restrictions on the compatibility of two consecutive coils. Whenever such incompatibility occurs, the coils must be bridged with a special dummy coil called stringer to maintain continuous production. The use of stringers reduces efficiency by adding costs and emissions as well as the consumption of valuable production time. We consider the scheduling of coils with specific

due dates and alternative order-specific processing modes on parallel heterogeneous annealing lines. The problem is to simultaneously assign coils to lines and sequence them on these lines with a defined processing mode while minimizing the number of stringers needed and the number of delayed coils. We formulate the problem as a mixed-integer linear problem based on a model developed by Mujawar et al. (2012). To solve the problem, we propose a two-phase heuristic with an opening and an improvement phase. In the opening phase, a greedy heuristic is used to generate an initial solution in a short time. To further improve that solution, we develop a tailored matheuristic based on Fix-and-Optimize that applies problem-specific decompositions. The results for instances with up to 200 coils show that the developed two-phase heuristic outperforms a commercial state-of-the-art solver, both in the quality of solutions and computation time. Based on an epsilon-constraint analysis we find that the trade-off between efficiency and tardiness depends strongly on the production environment, i.e., the heterogeneity of orders and the planning-flexibility resulting from upstream and downstream processes and intermediate inventories.

Sarah Roth (Universität Mannheim, Prof. Dr. Raik Stolletz)

Workforce scheduling with split shifts

Workforce Scheduling is an important task in various industries such as service, health care and logistics. In some businesses there are high demand peaks with a long idle time in between them e.g. in public transport the bus drivers' demand peaks correspond to the rush hours in the morning and the late afternoon. In assisted living facilities for people with disabilities the demand peaks follow a similar pattern. While the care assistants' demand peaks lie in the morning and evening, the demand for them is clearly lower during the day when the inhabitants are at work. To deal with this time-dependent variability in demand, the personnel can be scheduled in split shifts. These are shifts interrupted by a long, unpaid break of several hours. As these shifts are perceived as stressful by many employees, many health care institutions introduced a compensatory payment for working split shifts. This project aims at analysing the effect of split shifts on the cost-efficiency of the schedule.

5. Sitzung, Leitung: Prof. Dr. Manuel Ostermeier (Universität Augsburg)

Stefan Voigt (Katholische Universität Eichstätt-Ingolstadt, Prof. Dr. Heinrich Kuhn)

Meta-analysis of operators in ALNS for vehicle routing problems

This presentation systematically reviews the literature on adaptive large neighborhood search (ALNS) to gain insights into the operators used and their efficiency.

The ALNS has been successfully applied to a variety of optimization problems, most notably variants of the vehicle routing problem. The basic idea of the ALNS is to gradually improve an initial solution by modifying it via destroy and repair operators. The selection of operators depends on their historical performance during the search. Authors usually propose a large set of destroy and repair operators and rely on the adaptive component of the ALNS to select the most efficient operator. In addition, authors often conduct experiments to identify operators that benefit to the solution quality or to identify (and remove) detrimental operators. This process is mostly cumbersome, as there exists a wide variety of operators, sometimes the same operators under different names, or - vice versa - different operators under the same name. The goal of this article is twofold: Firstly, it aims to classify operators with consistent wording, and secondly to analyze their performance and establish a common basis for future works. We analyze the performance via a meta-analysis of 218 articles that meet our criteria. Furthermore, we re-implement the most commonly used operators and test their performance on well-known instances for the VRP and the VRP with time windows.

Niklas Tuma (Technische Universität München, Prof. Dr. Alexander Hübner)

Logic-based Benders decomposition for a vehicle routing problem with a zone-based tariff scheme

We address a rich vehicle routing problem (R-VRP) from a do-it-yourself (DIY) retailer with more than 500 stores. Like many peers, the retailer does not operate its own fleet but has two options to utilize external logistic service providers. The first option is to determine their own delivery tours that are then carried out by external carriers. The carriers bill according to a zone-based tariff scheme, including volume discounts.
The second option is to outright outsource individual deliveries that are then shipped to stores via transshipment warehouses. The retailer needs to evaluate both options and adhere to various side constraints for the routing, in particular, to detour limits implied by the external carriers. We formulate the resulting industry problem as a multi-depot, open vehicle routing problem with a heterogeneous fleet and an outsourcing option (MD-HF-OVRP-PC).
The literature on VRPs predominantly considers model and solution approaches relying on distance-based costs, neglecting that other tariff schemes are widely applied in retail practice. Hence, most prevailing approaches are not suitable for the problem at hand due to the nonlinear structure of the zone-based tariff.
We propose an exact logic-based Benders decomposition approach to solve the MD-HF-OVRP-PC. We show that the newly developed algorithm solves the problem in sufficient time. Further, we highlight the savings potential of our solution approach compared to the retailer's status quo.

David Fleckenstein (Universität Augsburg, Prof. Dr. Robert Klein)

Integrated demand management and vehicle routing for shared mobility-on-demand systems in rural areas

The steadily growing number of shared mobility-on-demand services bears the potential to make public transport more customer-friendly, sustainable, and profitable by pooling customers with compatible itineraries. At present, the growth of such services is primarily limited to cities. However, in rural areas, providers struggle to operate profitably as demand is lower and more dispersed, making efficient pooling of different customer requests challenging. We consider a rural service provider that dynamically receives a stream of customer requests via a mobile application and must control both the booking process and service fulfillment. From the operational planning perspective, this leads to an integrated demand management and vehicle routing problem with overlapping booking and service horizons, which we formalize as a Markov decision process. Tractable solution concepts usually rely on decomposition, i.e., they determine demand control and vehicle routing decisions based on a feasibility check and an opportunity cost estimation for each arriving customer. We present such a decomposition-based solution concept specifically adapted to the problem setting of service providers in rural areas. Drawing on a data-driven case study, we investigate in which environments active demand management can contribute to the system performance.

6. Sitzung, Leitung: Prof. Dr. Sven Müller (RWTH Aachen)

Milena Grieger (Universität Augsburg, Prof. Dr. Jens O. Brunner)

A sensitivity flexible Machine Learning classifier for predicting ICU capacity usage

The significantly increasing number of publications on Machine Learning in various application areas illustrates the increasing importance of the topic in recent years. In health care, probably fueled by the COVID-19 pandemic, this trend is also noticeable. Among others, researcher aim at supporting physicians, health care workers, and hospital managers by means of AI-assisted binary classification of patients (decision support systems). The application of binary classification enables, for example, an accurate prediction of whether a patient needs ward or intensive care unit treatment after surgery. In hospitals, intensive care units are a scarce resource, so any incorrect prediction can lead to a capacity problem and endangers patients' health. While the state-of-the-art application of Machine Learning methodologies focuses on the accuracy of the overall prediction, the priority in health care is often on a specific label, i.e., high sensitivity, for example in case of the intensive care treatment label. With the development and implementation of weighted sensitivities, it is possible to prioritize a particular label while maintaining high accuracy. The performance of these weighted sensitivities is tested and

evaluated based on a dataset of more than 26,000 patient courses after elective surgery and compared to various Machine Learning methods for binary classification, such as Logistic Regression.

Seyed Mohammad Zenouzzadeh (Universität Mannheim, Prof. Dr. Raik Stolletz)

A Machine Learning approach for the analysis of time-dependent queues: ML4TDQ

Many real world queueing systems operate in a time-dependent environment whether due to the cycles related to time of the day or seasonality or long-term changes to the environment caused by changes in the system configuration or parameters. Analysis of these time-dependent systems can be performed through the analysis of the transient behavior of queues with time-invariant parameters. We propose an algorithm to combine transient analysis models iteratively to estimate the behavior of time-dependent queues. For the transient analysis of analysis of queues, we propose two methods. The first method uses machine learning to estimate the transient performance measures and the second method combines machine learning with domain knowledge in a two-step framework in order to be more explainable and remedy some of the well-known shortcomings of machine learning methods, e.g., being uninterpretable and overfitting. These methods are general in that they do not require enforcing many restrictive assumptions on the underlying data and they are very time-efficient after the training is completed. Lastly, through extensive numerical experiments, we show the effectiveness of the methods proposed in this work in the analysis of time-dependent queues.

7. Sitzung, Leitung: Prof. Dr. Sebastian Schiffels (Universität Augsburg)

Lorena S. Reyes-Rubiano (RWTH Aachen, Prof. Dr. Sven Müller)

Evaluation of an integrated mobility concept for home care workers and ambulant patients

Hospital treatment and home care face rising demand in Europe. The rise is caused by increased life expectancy and the growing trend of old people living alone. Thus, the demand for transporting home care workers and vulnerable people is increasing. Today, the transport of home care workers and vulnerable people is performed independently of each other, leading to congestion in urban areas. We propose an integrated mobility concept to deal with the transport of home care workers and non-time-critical patients. The integrated mobility concept involves a trip-sharing system and the additional option of walking for home care workers. The home care service provision is related to the drop-off and pick-up of home care workers at the home of patients. Vulnerable people are transported from their homes to hospitals

or other medical facilities and then picked up after the end of their hospital treatment. We consider that each home care worker and home care job have an associated qualification level. This work addresses the transport of non-time-critical patients and home care workers.
Different qualification levels, service time windows, maximum ride times and maximum working hours must be considered. We implement a matheuristic algorithm to determine this integrated transport. We design a series of computational experiments to evaluate the impact on the waiting and driving times of home care workers and non-critical patients. Afterwards, we will compare individual trips' waiting and driving times versus shared trips. This evaluation may shed light on standards for waiting and ride times.

Markus Schüller (Universität Augsburg, Prof. Dr. Jens O. Brunner)

An approach for automated vacation planning in hospitals under consideration of employee satisfaction

In recent years, health care staff is confronted with a rising number of challenges. In particular, valuable time of senior physicians is spent on administrative tasks (e.g., creation of duty rosters or deciding of personnel's vacation requests) rather than on the patient's bedside. By the automation of organization-oriented tasks, the workload of medical staff could be significantly reduced allowing a focus on patient's health. Most researchers in the field of organizational task automation in health care consider automated duty scheduling but mainly exclude vacation planning in their analyses. Indeed, a fair and equally distributed vacation plan is necessary to ensure constantly high care. In this work, we provide a Mixed-Integer Programming (MIP) approach to automate the vacation planning process of personnel in hospitals. We propose as many vacation periods as possible from previously submitted requests in compliance with ensuring sufficient personnel availability over all experience levels. Employee satisfaction is, in addition, ensured by distinguishing between priority and regular leave wishes. Furthermore, we introduce potentially applicable extensions of our initial model, like the consideration of in advance known seasonal staff fluctuations (e.g., conferences, flu waves, etc.). The model is tested with both exemplary test and real-world data of the University Hospital of Ulm, Germany.

Mira Baude (Universität Duisburg-Essen, Prof. Dr. Alf Kimms)

Minimizing humanitarian and economic damage in pandemic situations

The Corona pandemic has been with us for the last years and is still a major concern today. In order to control the spread of the virus, governments have taken political measures. In this talk, we present a mathematical model to minimize the economic

damage caused by measures with simultaneous consideration of humanitarian damage caused by infections. The model will be illustrated by examples.

8. Sitzung, Leitung: Prof. Dr. Simone Neumann (Universität Hamburg)

Thomas Hagspihl (Technische Universität München, Prof. Dr. Rainer Kolisch)

Improving airport access: On finding the optimal positions of vertiports for air taxis

Airports, airlines and passengers share a common interest in providing passengers with fast and convenient access to airports. With the introduction of air taxis as a new transportation mode, the question arises as to where facilities for air taxis to land and take off, also called vertiports, should be established to maximize the benefit of the new offer for passengers. Existing literature finds that travel time and travel costs are the primary factors relevant to passengers when deciding which mode of transportation to use. We formulate the problem as a p-hub location problem and incorporate passenger preferences explicitly using a linearized multinomial logit model. We apply the model to Munich Airport in a detailed case study, suggest locations for vertiports throughout Bavaria as a result, and provide forecasts for the number of air taxi passengers to be expected.

Tobias Huf (Universität Augsburg, Prof. Dr. Manuel Ostermeier)

Robots at your service: Covering the last-mile in omnichannel retail

The number of home deliveries is ever increasing. This trend is nowadays not restricted to standard shopping but comprises a versatile product spectrum and likewise a variety of delivery modes and channels. Retailers establish omnichannel networks to address these challenges. Goods are not only supplied via central warehouses but increasingly delivered direct from stores. This enables a timely delivery (e.g., same day) and a satisfying shopping experience for customers. Yet this goes hand in hand with complex logistics and especially efficient solutions for the last mile of deliveries is needed. To address these challenges, we propose the concept of combining delivery trucks with autonomous robots. The concept uses robots carried by a dedicated truck for last-mile delivery and leverages an infrastructure of robot depots and drop-off locations. We extend the concept by integrating store locations and corresponding pickup and delivery request in the network. We formulate the problem as mixed integer program and propose a tailored solution approach to solve large scale instances needed for an application in industry.

Dr. Matthias Soppert (Universität der Bundeswehr München, Prof. Dr. Claudius Steinhardt)

Optimal Counterfactual Explanations for Target Score Value Distributions of Random Forest Predictors

Due to their effectiveness, random forests have become a popular method for prediction tasks such as classification. However, their lack of interpretability still hinders their widespread use in practice. A well-established approach to increase the interpretability of such machine learning predictors makes use of counterfactual explanations. A counterfactual explanation would answer a question of the type: ``What would need to change in the inputs to obtain a specific target output?" In addition to several existing heuristics for finding such explanations, a recent work provides the first method to obtain optimal counterfactual explanations. Optimal here means that the required input changes are as small as possible. In our work, we generalize this method. Instead of finding an optimal counterfactual explanation for a specific target classification, our method determines an optimal explanation for a target score value distribution that results from the random forest. This generalization has several advantages. For example, in addition to extending applicability, our method always returns a counterfactual explanation whereas the original one can sometimes only return an infeasibility. Moreover, considering the score value distribution instead of the class prediction provides the practitioner with much more information, further increasing interpretability.

9. Sitzung, Leitung: Prof. Dr. Dominik Kreß (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg)

Andreas Hipp (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg, Prof. Dr. Florian Jaehn)

Scheduling problems considering jobs with fixed position

In this research, we study classical single machine scheduling problems adding the constraint that a defined set of jobs must be scheduled on specific positions in the job sequence. We call these jobs “special jobs” that require starting on the machine after exactly a certain number of regular jobs is completed. Regular jobs are jobs without any given position restriction. Characteristics introduced via the well-known three field notation hold for both regular and special jobs, e.g. weights, ready times or due dates. We address the typical completion time, and due date related objective functions and analyze the runtime complexity of these layouts with fixed positioned jobs. In this work, the focus is on specific job characteristics, including equal processing times or equal due dates for all jobs. We show that some

layouts taking special jobs into account are still polynomial solvable but also present layouts for which the findings of the known problem without special jobs no longer hold.

Maximilian Kolter (Technische Universität München, Prof. Dr. Rainer Kolisch)

A branch-and-price approach for solving the multi-criteria multi-project scheduling problem for engineering automotive production systems

In the automotive industry, ever-shorter product life cycles and growing product portfolios have led to a high frequency of new product launches. The production systems for these products are usually very complex and product specific. Therefore, each new product introduction is associated with a project to engineer and implement its production system. For undertaking these projects, car manufacturers deploy inhouse manufacturing engineers and use outsourcing services from engineering services providers. Planning these projects requires the car manufacturer to decide on how many inhouse engineers to deploy, how to assign these engineers to activities, and which activities to outsource to which service providers. In practice, this planning problem is solved manually and is not optimized. Therefore, we present a multi-objective mixed integer programming model based on the resource-constraint multi-project scheduling problem to solve the planning problem. We consider two lexicographic objectives. The first objective maximizes the utilization of inhouse engineers, which is equivalent to minimize outsourcing. The second objective minimizes jumps in the resource profiles for the service providers to generate attractive outsourcing bundles. Currently, we are developing a decomposition algorithm based on column generation to solve the problem. The algorithm exploits the block structure of the problem and allows to generate schedules for each project independently. Furthermore, we are currently collecting data from a major European car manufacturer to conduct a computational study to obtain managerial insights into optimal project schedules, workforce compositions, and outsourcing strategies.

Julian Lütkemeyer (Universität Duisburg-Essen, Prof. Dr. Michael Manitz)

Simultane Personaleinsatz- und Maschinenbelegungsplanung

Es wird ein Praxisproblem aus der Elektroindustrie betrachtet, bei dem die Besonderheit besteht, dass die Auftragsbearbeitungszeiten abhängig sind von der Anzahl an Mitarbeitern, die für konstante Schichtlängen an Fertigungssystemen einzusetzen sind.

10.Sitzung, Leitung: Prof. Dr. Michael Manitz (Universität Duisburg-Essen)

Niklas Owens (Universität Regensburg, Prof. Dr. Justus Arne Schwarz)

A model and initial results for optimal product rollover strategies under uncertain supply

In various industries like fashion, consumer electronics and home appliances, firms frequently introduce new product generations to maintain or increase their market share. When transitioning from an old to a new product generation, firms have to decide on their product rollover strategy. They can either execute a single rollover strategy and phase out the old generation before introducing the new one, or sell both generations simultaneously, thus employing a dual rollover strategy. Uncertain demand and supply for the new product makes decision-making regarding pricing and production and sales quantities during a rollover difficult. While demand uncertainties have been addressed in the scientific literature, the effect of stochastic production processes on optimal production rollover strategies has not been studied. This talk proposes a mathematical model formulation that captures product rollovers under stochastic production processes and provides first numerical solutions.

Mirko Schömig (Technische Universität München, Prof. Dr. Martin Grunow)

Production capacity planning under demand and productivity learning rate uncertainty

We deal with the capacity planning problem of a biopharmaceutical firm or other firms with long and risky product development cycles. These firms need to balance the risk of delaying the start of production once the product is approved for market and the risk of unused capacity if the product fails. We consider two types of investments: Outsourcing the production lowers the investment at risk, but results in higher per unit production cost and prevents the originator company from improving their productivity due to learning. Inhouse investments enable productivity improvements but at an uncertain rate. We formulate the problem as a stochastic sequential decision model, i.e., MDP, and analyze the structural properties of the optimal decision policy.

Sebastian Schoepf (Universität Hohenheim, Prof. Dr. Herbert Meyr)

Resilientes Master Planning in der Elektronik

Im Rahmen zunehmender Globalisierung werden Liefernetzwerke immer größer und komplexer. Unsicherheiten in Bezug auf Liefermengen und -Zeiten sowie die Gefahr von Lieferantenausfällen, stellen Unternehmen vor große Herausforderun-

gen. Aktuelle Ereignisse wie Lockdowns in der Corona-Pandemie, die gegenwärtige Halbleiter-Krise oder Naturkatastrophen sind nur Beispiele einer langen Liste, welche die Funktionstüchtigkeit von Supply Chains beeinträchtigen können. Insbesondere in der Elektronikbranche treffen diese Umstände vermehrt zu und werden aufgrund besonderer Charakteristika noch verstärkt (hohe Wiederbeschaffungszeiten, Single Source Bauteile, …). Viele Unternehmen haben daher die Bedeutung eines systematischen Supply Chain Risk Managements (SCRM) erkannt, um Risiken und potentielle Lieferausfälle frühzeitig zu vermeiden oder das Schadensausmaß zu verringern.
Zur Steigerung der Resilienz in Liefernetzwerken müssen die Anforderungen des SCRM in den Planungsaufgaben des Supply Chain Planning Berücksichtigung finden. Dazu werden verschiedene Planungsmodelle im Bereich der Mittelfristplanung (Master Planning) entwickelt und eine Integration des SCRM auf unterschiedliche Art und Weise in die Modellformulierungen realisiert. Da dies meist mit der Erhöhung der Gesamtkosten einhergeht, soll folglich eine geeignete Lieferkette gefunden werden, die zum einen zur Gewinnmaximierung beiträgt, gleichzeitig aber auch ein gewisses Maß an Versorgungssicherheit garantiert. Mit dem Fokus auf Praxistauglichkeit werden die Modelle am Beispiel eines Industrie-Unternehmens untersucht sowie eine Resilienzanalyse durchgeführt.

11.Sitzung, Leitung: Prof. Dr. Stefan Helber (Leibniz Universität Hannover)

Antonia Thiemeyer (Bergische Universität Wuppertal,
Prof. Dr. Dirk Briskorn)

Scheduling maintenance activities subject to stochastic job-dependent machine deterioration

In many machine scheduling models, unrestricted machine availability is assumed. However, in real world settings the machine needs to be maintained from time to time which has a direct impact on the processing of the jobs. For this reason, we consider machines whose availability depends on their maintenance level.
In this talk we consider the problem of scheduling maintenance activities (MAs) for a given sequence of jobs on a single machine with the goal to minimize the expected total completion time. The maintenance condition is deteriorated by the execution of the jobs. How much it deteriorates depends on each job individually whose deterioration is subject to a discrete probability distribution. If the deterioration exceeds the maintenance level a costly emergency MA needs to be carried out to ensure the continuation of processing.
We distinguish between two different model assumptions concerning the machine properties. The machine under consideration is either transparent or non-transparent. In the case of a transparent machine, the user can read out the current maintenance level of the machine between two jobs and decide on the basis of this

information whether a MA should be carried out. In the case of the non-transparent machine, the user does not have these information and decides on the maintenance schedule in advance of the processing.
We want to present and compare solution procedures and results for both approaches to see what additional value the property of transparency of the machine has for the user.

Jan-Niklas Dörr (Technische Universität München, Prof. Dr. Martin Grunow)

Action space designs for stochastic production scheduling with sequence-dependent setup times

We investigate flexible shop scheduling problems with sequence-dependent setup times. In many practical environments, setup times as well as processing times are stochastic, requiring solution approaches that are able to react dynamically to uncertainty.
The problem can be expressed as a dynamic programming problem in which a new decision epoch is reached whenever a machine becomes idle. Accordingly, we define a Markov decision process (MDP) formulation, which serves as a generic basis for real-time scheduling. As policy approximations, we suggest multiple methods based on (Deep) Reinforcement Learning (RL) and priority rules developed by Genetic Programming (GP). The design of the action space defines the solution space and thus influences the quality of the policy approximation. Action spaces are created to address the additional complexity imposed by specific characteristic of the problem, such as sequence dependent setups. We evaluate our different action space designs regarding their suitability for solution methods, and their ability to generalize.

Thorsten Greil (Technische Universität München, Prof. Dr. Martin Grunow)

The environmental impact of considering uncertainty in supply chain planning

Companies increasingly wish to adopt concepts such as “Probabilistic Planning” for better protection against supply chain uncertainty. Adopting such more complex planning approaches might create diverging environmental sustainability effects – either benefit or harm. Therefore, we investigate a sequential decision-making setting for master production scheduling where a profit-maximizing firm switches from a simplified, status quo planning approach (deterministic) to an explicit consideration of uncertainty (stochastic).
We first outline a process to evaluate the two planning policies in a stochastic base model simulator regarding their economic performance. This is to ensure a fair comparison and to incorporate established planning paradigms such as replanning based on updated information (rolling horizon). We then propose a process to

evaluate the economic optimizations' impact on global warming. For this, a standardized measurement (greenhouse gas emissions in CO2 equivalents) is attributed to the planning decisions in scope. Companies might not necessarily include environmental targets directly (i.e. in the objective or constraints) into their decision making but might stick to economic objectives – e.g. max profit or min cost. Thus, this framework can be used to analyze worst case outcomes for the environment of adopting more complex planning procedures.
We aim to show that whether a stochastic planning approach can improve (i.e. reduce) or worsen (i.e. increase) the environmental impact in comparison to a simplified planning approach depends on (i) problem structure (e.g. available decision options and their relative environmental implications), (ii) the availability and quality of data on uncertainty (i.e. is there a significant advantage to plan stochastically) and (iii) the magnitude of the underlying uncertainty.
This work opens up a new field for future research as it could help in guiding thoughtful adoption of supply chain planning processes towards a more sustainable future.

Baturhan Bayraktar (Technische Universität München,
Prof. Dr. Rainer Kolisch)

Stochastic programming for solving the dynamic assembly matrix layout problem

Increasing uncertainty in demand for the products as a consequence of rising customization and new technological advancements affects the productivity of traditional assembly lines. The matrix-shaped assembly layouts where automated guided vehicles move products between the workstations placed in a grid arrangement attract the layout designers due to their easy reconfigurability in case of demand changes. In this study, we develop a two-stage stochastic programming technique for designing and adapting the matrix assembly layouts under uncertain demand in a multi-period horizon. We consider the uncertainty of the product demand with several realistic scenarios. Our here-and-now decisions consist of the locations of the active stations and task assignments to the stations. In the second stage, the flow decisions and necessary reconfigurations are made after the demand for each product is revealed. The objectives are to maximize the efficiency of the layouts while minimizing the expected number of reconfigurations and total travel distances of the products on the manufacturing layout. We formulate a lexicographic multiobjective mixed integer linear programming model to solve the problem exactly. Our solution procedure also employs a decomposition methodology to solve practice-size instances in real-life timeframes. The experiment design evaluates the value of the stochastic solution for uncertain demand against its deterministic counterparts with the problem instances derived from the literature.

12. Sitzung, Leitung: Prof. Dr. Florian Jaehn (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg)

Rea Röntgen (Bergische Universität Wuppertal, Prof. Dr. Dirk Briskorn)

Free-floating electric carsharing problem with partial charging

Free-floating carsharing offers its users the convenience of returning a car rented on a short-term basis to any location within a specified service area. The resulting increase in flexibility for carsharing users is countered by an imbalance of vehicles between different locations, e.g., city districts. To compensate for this, the carsharing provider often hires extra staff to relocate the vehicles. Especially for electric cars, which require more time to recharge at fewer stations than conventional cars, the problem of generating a high level of service for carsharing users while increasing the provider's profit becomes more complex. We therefore consider the problem of scheduling the various customer requests and the resulting charging requests on vehicles with the option of partial charging, and refer to this problem as the free-floating electric carsharing problem with charging and relocation (FFECP-R). We formulate it as a MIP model and propose an Adaptive Memory Search approach as well.

Kai Winheller (Universität Duisburg-Essen, Prof. Dr. Rouven Schur)

Dynamic compensations for occasional drivers

The last decades have shown a trend of customers adopting the behavior to purchase their products online. This results in an increasing demand for last mile delivery services for retailers. “Crowd-shipping” is a business concept which promises lower delivery cost and a faster delivery while providing potential benefits to the environment. It utilizes non-contractual occasional drivers (ODs) deliver customer orders for a (monetary) compensation. ODs are customers who are willing to deliver customer order(s) while on their way from the local store to their destination and who have some space to spare in their trunks. The research on incorporating ODs into an optimization model has gained momentum since the publication of the vehicle routing problem with occasional drivers (VRPOD) in 2016 by Archetti et al. One of the aspects frequently identified as a key factor is the compensation that is offered to an OD. In most models, the arriving ODs are offered a fixed amount and are believed to always accept the offer. Another frequently made assumption is the certain and simultaneous arrival of a known set of ODs. We drop this assumption by modeling the problem as a stochastic dynamic program (DP) where ODs arrive dynamically in time. The objective is minimizing the total expected cost of delivery. Since the OD’s intrinsic willingness to deliver a product is unobservable and their arrival uncertain, there are benefits in setting compensa-

tions dynamically. In our presentation we introduce the VRPOD-DP, present algorithms to tackle this difficult optimization problem, and show first results of our numerical study.

13. Sitzung, Leitung: Prof. Dr. Heinrich Kuhn (Katholische Universität Eichstätt-Ingolstadt)

Finn Meissner (Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg, Prof. Dr. Florian Jaehn)

Determining airplane boarding groups

The boarding process of airplanes is usually part of the critical path of an airplane's turn-around. As time at the gate is costly, it is vital for airlines to optimize this process. For this purpose, multiple boarding policies have been developed and extensively investigated in boarding literature.
Most policies divide the passengers into boarding groups within which the participants are randomly ordered. In the related literature, the number of groups and the allocation of seats to the groups are often determined in advance, and then the performance of the boarding policy is measured.
In this paper, the seat allocation itself is optimized so that a division into boarding groups can be found for the given parameters. A model is provided that considers a finite walking speed. This approach is not limited to the policies used in the simulation and can lead to the determination of new boarding group layouts that are not known in practice.

Niklas Pöch (Leibniz Universität Hannover, Prof. Dr. Stefan Helber)

Vehicle routing for inductive charged passenger buses on airport aprons

Due to climate change, sustainability is playing an increasingly important role in the aviation sector. One measure to reduce emissions is the electrification of ground vehicles on the airport apron. Dynamic inductive charging, in which vehicles are wirelessly charged while driving, is particularly suitable for apron vehicles. This technology can eliminate downtime for charging electric vehicles compared to conductive charging. We are considering the routing of the electric passenger buses on the airport apron. These passenger buses use an inductive charging infrastructure for charging their battery. The aim is to ensure reliable operation. This means there should be no delays, and the vehicles should not break down due to an empty battery. We focus on a first model formulation to describe the presented problem.

14.Sitzung, Leitung: Prof. Dr. Alexander Hübner (Technische Universität München)

Marius Drechsler (Hochschule Geisenheim University, Prof. Dr. Andreas Holzapfel)

Procurement and production planning for horticulture with consideration of short-term re-orders

For small and medium-sized enterprises in the horticultural business, the procurement and production planning of ornamental plants, perennials and cut flowers constitutes significant challenges. Lead and production times of several months, as well as distinctive seasonality and high perishability of the products have to be considered. Reflecting these challenges, companies usually distinguish between own production or pre- and re-orders. Own Production as well as pre-orders with several months of lead time before the start of the selling season guarantee a basic availability and sufficient quality. Re-orders during the selling season have at most a few weeks of lead time and thus offer short-term flexibility, but are uncertain and fluctuate in price and quality. We present a stochastic procurement and production planning model reflecting these conditions. A MILP approximation provides production/pre-order quantities and estimates necessary re-order quantities for the selling season.

Alexander Pahr (Technische Universität München, Prof. Dr. Martin Grunow)

Ameliorating food inventory management

Amelioration of food inventory during storage facilitates product differentiation according to age and, consequently, induces a trade-off between immediate revenues and further maturation.
Decision makers need to integrate recurring fulfillment decisions for multiple products. The sales revenue in each period depends on the fulfillment volumes as well as on the stochastic demand realization. To provide for future periods, planners also need to purchase fresh units that start the maturation process. The purchasing price for these stocks varies dependent on the harvest yield. Further, the maturation process is subject to decay risks.
We model the problem of managing ameliorating food inventory as a Markov decision process. States are characterized by the purchasing price level and the inventory volumes in different age classes. Both the state space and the transition space grow exponentially in the number of age classes. For small problems, we derive the optimal policy through Value Iteration. We show that the optimal purchasing quantity decreases with the price level. To solve intractable large problems, we propose a Deep Reinforcement Learning Algorithm based on Proximal Policy Optimization. To enhance the learning process, we use insights from the optimal solution to small problems.

Julia Heger (Universität Augsburg, Prof. Dr. Robert Klein)

Partition-constrained assortment optimization under the multinomial logit model

We study the retail assortment optimization problem under the well-known multinomial logit choice model with three different types of partition constraints. Under such partition constraints, the products are attributed to (not necessarily disjoint) groups and there is either a bound on the number of products offered per group or on the number of groups from which products are offered. Each of our three constraint settings is introduced by outlining selected practical use cases. We formulate the optimization problem for each of the three settings as binary fractional linear programs that are known to be NP-hard and provide LP respectively MILP reformulations of these settings. These LP respectively MILP reformulations can then be solved efficiently using common state-of-the-art solvers such as CPLEX or Gurobi. Finally, we conduct an extensive numerical study using synthetic data and provide empirical evidence of the practical applicability of our approach even for larger problem instances.

15. Sitzung, Leitung: Prof. Dr. Claudius Steinhardt (Universität der Bundeswehr München)

Christin Münch (Universität Duisburg-Essen, Prof. Dr. Alf Kimms)

Zum Path Planning Problem für Drohnen unter Berücksichtigung von Geschwindigkeit und Energieverbrauch

Mit voranschreitendem technologischem Fortschritt gewinnt die Belieferung mit Drohnen sowohl in Praxis als auch Forschung zunehmend an Interesse. Während die meisten Paper zur Last-Mile Delivery mit Drohnen ihre Anwendung im städtischen Raum finden, konzentrieren wir uns in dieser Arbeit auf die Belieferung von Krankenhäusern mit Medikamenten in ruralen Gebieten. Da hier die Flugwege deutlich länger sind ist es notwendig die Geschwindigkeiten der Drohnen zu optimieren, da diese direkt den Energieverbrauch und damit auch die maximale Reichweite bestimmen. Um in einem späteren Schritt einen Truck als mobilen Spart- und Landepunkt hinzufügen zu können, haben wir ein Path Planning Problem für Drohnen unter Berücksichtigung von Geschwindigkeit und Energieverbrauch aufgestellt.

Karolin Eisele (Universität Duisburg-Essen, Prof. Dr. Alf Kimms)

Zellenbasierte Ansätze für das Firefighter Problem am Beispiel der Hochwasserbekämpfung

Bei Katastrophen wie Buschbränden, Pandemien oder Hochwasser ist es wichtig

Einsatzkräfte gezielt einzusetzen, da oft nicht viel Zeit für die Gefahrenabwehr bleibt und die Anzahl der Einsatzkräfte limitiert ist. Diese Herausforderung wird im Rahmen meines Dissertationsprojektes mittels eines zellenbasierten Ansatzes adressiert. Dabei sollen verschiedene Aspekte, wie z.B. Höhenunterschiede im Gelände berücksichtigt werden. Zur Lösung dieses Problems werden Prioritätsregeln diskutiert.

Christian Jäck (Universität Duisburg-Essen, Prof. Dr. Jochen Gönsch)

How to load your auto-carrier. A hybrid bin-packing approach for the auto-carrier loading problem (ACLP)

The distribution of finished vehicles is a complex task and a high cost factor for automotive original equipment manufacturers (OEMs). On the way from the production plant to the customer, the new vehicles travel long distances on different transport carriers such as ships, trains, and trucks. To save costs, OEMs and logistics service providers aim to maximize their loading capacities. Modern auto-carrier trucks are extremely flexible. Individual platforms can be rotated, extended, or combined to accommodate vehicles of different shapes and weights and to nest them in a way that makes the best use of the available space. In research, most papers that deal with auto-carrier loading focus on route or cost optimization. Only a rough approximation of the loading sub-problem is considered. In practice, it is the task of the truck operator to figure out how and where to position the vehicles on his auto carrier. Because of the flexibility of the auto carrier and the many restrictions this is can be a complicated and time consuming task. The goal of our research is not only to approximate realistic load factors but to generate a loading pattern that is accurate and realistic enough to serve as a guide on how to load the auto carrier. We solve a real world problem of an automotive company in Germany. To solve the problem, we use a hybrid procedure combining a mixed integer linear model formulation with geometric calculations and a nesting algorithm.

16.Sitzung, Leitung: Prof. Dr. Rouven Schur (Universität Duisburg-Essen)

Karen Flores-Hundt (Universität Duisburg-Essen, Prof. Dr. Alf Kimms)

Budgetallokation in der Katastrophenhilfe zur Bereitstellung von Transportkapazitäten

Nach einer Katastrophe, die durch die Natur oder durch menschliche Aktivitäten verursacht werden, müssen Hilfsgüter wie Trinkwasser, Lebensmittel und Medikamente zum Unglücksort transportiert werden. Für diese Aufgabe benötigen Hilfsorganisationen verschiedene Transportmittel, die jedoch mit einem begrenzten Spendenbudget bezahlt werden. Ziel ist es, das Budget effizient einzusetzen, damit möglichst viele Hilfsgüter in das betroffene Gebiet verteilt werden.

Abtin Nourmohammadzadeh (Universität Hamburg, Prof. Dr. Stefan Voß)

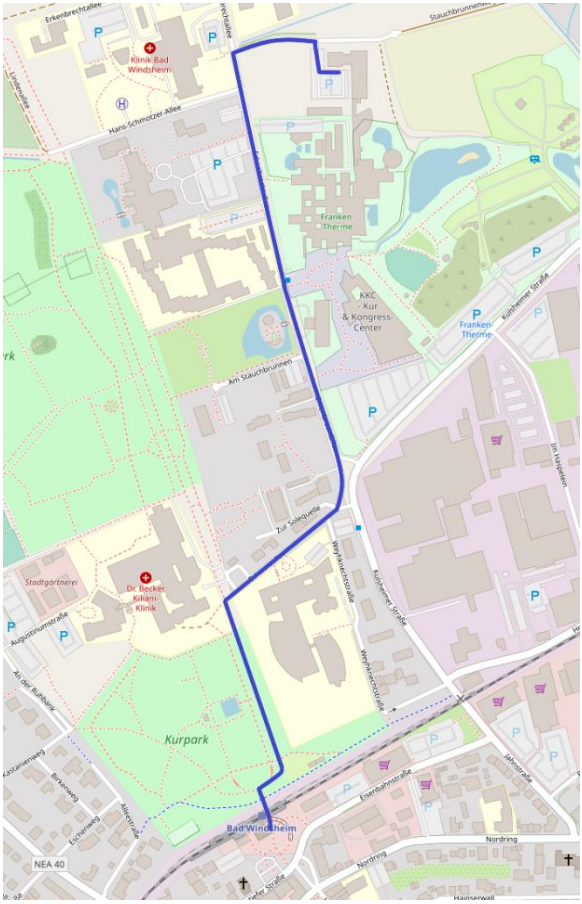
A matheuristic approach for the family travelling salesman problem

The family travelling salesman problem (FTSP) is a very special and practical variant of the TSP, in which the cities are presented in groups called families and the salesman has to visit only a subset from each family. Due to the high computational complexity of this problem and the impossibility of using a pure mathematical programming approach with a standard solver, we propose a matheuristic method consisting of a genetic algorithm (GA) as its main framework, where in each iteration, local improvements based the simulated annealing (SA), and also consecutive exact optimisations in parts of a selection from the population are implemented. The latter is done by solving tractable partial mathematical models of the problem using CPLEX. The results of our approach are compared with those of a pure metaheuristic as well as a state-of-the-art peer method.

Informationen zu Hotel und Tagungsort:

Hotel:
Vital HOTEL an der Therme GmbH (garni)
Erkenbrechtallee 14, 91438 Bad Windsheim
Telefon: 09841 689990

Wegbeschreibung vom Bahnhof zum Hotel (ca. 15 Minuten Fußweg):



Hotelparkplätze stehen direkt beim „Vital Hotel an der Therme“ zur Verfügung.

Tagungsort:
Kur- & Kongress-Center (KKC) Bad Windsheim
Erkenbrechtallee 2, 91438 Bad Windsheim

Wegbeschreibung vom Hotel zum Tagungsort (ca. 5 Minuten):